spctoolkit

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Which Chart Should I Use?

In the previous columns, we saw examples of the basic control chart for individual values. This chart is recommended whenever you obtain data one value per time period, or one value per shipment.

The second major type of control chart is used when the data have been arranged into subgroups. Here we are typically concerned with data where several values are obtained in a short period of time. For example, an auto plant in Portugal received shipments from a supplier in Germany. The part was a piece of wire for connecting the horn buttons to steering wheels. These wires were supposed to be 100 mm long. Every time they received a shipment, the Portuguese selected five wires and measured the lengths. The data for the first four shipments and a table of control chart constants are shown below:

-1-	-2-	-3-	-4-	Control Chart Constants		
114.8	108	113	114.s	*n*	A_2	D_4
115.2	115.8	114	113	2	1.880	3.268
114	111	114.4	113	3	1:023	2.574
112	104	113.6	113	4	0.729	2.2%2
114.5	106.2	112	113	5	0.577	2.114

A "subgroup" should consist of a set of measurements which, in the user's judgment, represent essentially the same set of conditions. The concept here is that while each subgroup should be more or less homogeneous, the control chart will examine the data to see if there are differences from one subgroup to another. In this example, each set of five measurements came from one shipment. The pieces of wire in each shipment were made in the same short production run and under essentially the same conditions. Therefore it is logical to make each shipment a subgroup.

With subgrouped data, we plot the subgroup averages and subgroup ranges. Therefore, we must begin by computing averages and ranges for each subgroup. For each shipment, the average of the five values will be the subgroup average. The range of a subgroup will be the difference between the maximum value and the minimum value in that subgroup. For the first shipment, the maximum value is 115.2, while the minimum value is 112. Thus the subgroup range is: 115.2-11 2.0= 3.2 units.

After the average and range have been computed for each subgroup, these values are plotted in two running records. Conventionally, the averages are plotted on the upper running record and the ranges are plotted on the lower running record.

The limits for this average and range chart are computed from the data according to the following steps:

The average of the subgroup averages is obtained. This value , is called the grand average. Here the grand average is 1 I 2.45. This value will be the central line for the upper portion of the chart.

The average of the subgroup ranges, called the average range, is also obtained. Here the average range is 4.725. This value will be the central line for the lower portion of the chart.

The control limits for the average and range chart are computed using the grand average and the average range. The upper control limit for the average chart will be:

Grand Average + (A_2 times Average Range)

= 112.45 + (0.577 *X* 4.725)= 115.2

The lower control limit for the average chart is:

Grand Average - (A2 times Average Range)

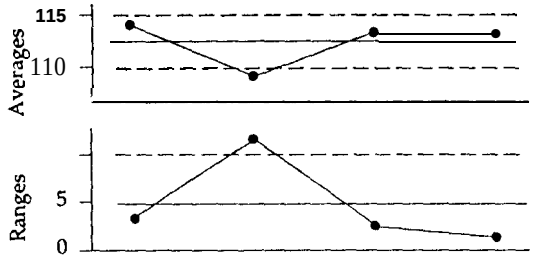
= 112.45- (0.577 *X* 4.725) = 109.7

The upper control limit for the range chart is:

D_4 times Average Range= 2.114 x 4.725= 10,0

where A_2 and D_4 are the appropriate control chart constants for a given subgroup size. They are those values which allow us to convert the grand average and the average range into control limits.

Shipment:	-1-	-2-	-3-	-4-
Averages	114.1	109.0	113.4	113.3
Ranges	3.2	11.8	2.4	1.5



As may be seen on the average and range chart, one average and one range fall outside their limits. Shipment Two has a lower average and a greater range than the other shipments. Due to the way the data were arranged into subgroups, the average chart characterizes each shipment's location—the average length of the wires in that shipment, while the range chart characterizes each shipment's consistency—the dispersion of the lengths of the wires in each shipment.

Clearly, the four shipments have different locations and dispersion. Moreover, since the target is 100 mm, all shipments were far above the target. Based on this record of inconsistency, both within and between the shipments, the German supplier was

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dropped. The other suppliers were much more consistent in the product they delivered.

This example serves to introduce the second of the two major types of control charts-charts for subgrouped data. When several values are collected under essentially the same conditions, it is logical to place these values in subgroups and use an average and range chart. The key to effective average and range charts is to have subgroups that are internally homogeneous. This is, of course, a judgment made by the user. It is the means by which users get to bring their process knowledge to bear upon the chart.

When the data are collected in such a way that each value may differ from the others, it is logical to place the data on a chart for individual values. This commonly occurs when the values are obtained individually.

While there are other types of control charts, they are all special cases of the two charts above. They are either charts for subgrouped data, or charts for individual values. Once you have learned how to use an average and range chart and a chart for individual values, you can work with virtually any type of data, in any type of situation.

About the author . . .

Donald J. Wheeler is an internationally known consulting statistician and the author of Understanding Variation: The Key to Managing Chaos *and* Understanding Statistical Process Control, Second Edition.